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Erythrophleum ivorense: a synthesis and review of its chemistry, pharmacology and medicinal potential

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Abstract

Erythrophleum ivorense is a large tree widely used as traditional medicine in West Africa. The present review aims to provide a comprehensive report on the botany, medicinal uses, phytochemical and pharmacological properties of *E. ivorense*. Several electronic search engines and specialized reference tools such as Google, Google Scholar, Scopus, Web of Science, scientific literature, publishing sites and electronic databases (Pubmed, Springer, Wiley and Science Direct) were used for data retrieval. The bark, leaves and stem bark of *E. ivorense* are mainly used as anthelmintic, emetic, insect repellent, laxative and traditional medicine for convulsions, malaria, pain, smallpox, swellings and wounds. The bark, leaves, root bark, stems and stem bark of *E. ivorense* contain alkaloids, cassaine, erythrophleine, anthracenosides, cardiac glycosides, coumarins, flavonoids, phenolics, saponins, sterols, tannins and terpenoids. Pharmacological research revealed that the bark, leaf, root bark and stem bark extracts of *E. ivorense* and compounds isolated from the species have antibacterial, antifungal, anticonvulsant and sedative, antigiardial, anti-inflammatory, anti-leishmanial, antioxidant, antischistosomal, antitrypanosomal, insecticidal and cytotoxicity activities. There is need for clinical and toxicological evaluations of crude extracts and compounds isolated from the species since *E. ivorense* contains potentially toxic compounds.

Keywords: Caesalpinioideae, ethnopharmacology, *Erythrophleum ivorense*, Fabaceae, herbal medicine, indigenous pharmacopeia

INTRODUCTION

Erythrophleum ivorense A. Chev. is a large tree belonging to the subfamily Caesalpinioideae of the Fabaceae family. *Erythrophleum ivorense* is an important source of traditional medicines in tropical Africa, and this species is included in the book "Plant resources of tropical Africa 11: medicinal plants 1". This book is an encyclopaedic guide on plants widely used as traditional medicines in tropical Africa, including their medicinal applications, ethnopharmacological properties, description, geographical distribution, trade, management and ecology.[1] The bark of *E. ivorense* is sold as 'sassy-bark', 'mancona bark', 'casca bark' or 'écorce de tali' in informal herbal medicine markets in West Africa.[2] Closely related species such as *E. africanum* (Welw. ex Benth.) Harms, *E. couminga* Baill. and *E. suaveolens* (Guill. & Perr.) Brenan are also regarded as important sources of traditional medicines in tropical Africa.[2-7] Gorel et al.[8] argued that *E. africanum*, *E. ivorense*, *E. lasianthum* Corbishley and *E. suaveolens* are multipurpose trees characterized by high economic and socio-cultural values. For example, *E. ivorense* and *E. suaveolens* are listed as important sources of timber in the book "Plant resources of tropical Africa 7(2): timbers 2" with 2005 export figures of the two species from Cameroon to China amounting to 37500 m^2 and 38600 m^2 of logs and sawn wood, respectively.[2,7] But the bark and seeds of *E. ivorense* are considered poisonous and therefore, the species is used as fish poison, arrow poison, poison for rats and game and ordeal poison.[2,9] Closely related species such as *E. africanum*, *E. chlorostachys* (F. Muell.) Baillon, *E. couminga*, *E. lasicanthum* and *E. suaveolens* are also known to be poisonous.[10-17] It is therefore, within this context that this review was undertaken aimed at reviewing the botany, medicinal uses, phytochemical and biological activities of *E. ivorense* so as to provide baseline data required in evaluating the therapeutic potential of the species.

Botanical profile of *Erythrophleum ivorense*

The genus *Erythrophleum* Afzel. ex G. Don consists of about 10 species distributed in continental Africa, Madagascar, eastern Asia and Australia.[2] The genus name is derived from the Greek words "*erythros*" meaning "red" and "*phloios*" meaning "bark of trees", that is, red bark in reference to red sap produced by some African tree species.[9] Several species of the genus are often called "redwater trees" because a red sap is exuded when the bark is cut and this colours water red.[13] The specific name "*ivorense*" is derived from Ivory Coast, another name for Côte d'Ivoire, where the type specimen of the species was collected. The English common names of *E. ivorense* include "ordeal tree" and "sasswood tree". Synonyms associated with this species include *E. micranthum* Holland and *E. micranthum* Harms ex Craib.[9] *Erythrophleum ivorense* is a large tree which can be 40 metres in height.[2] The bole is cylindrical, but sometimes fluted at the base, with or without buttresses. The inner bark is reddish in colour, but the outer bark is grey in colour, smooth in young trees and becoming red-brown, granular, rough and fissured with age. The leaves are alternate and leaflets are elliptical to ovate in shape. The leaf apex is shortly acuminate while the base is asymmetrical. The inflorescence is axillary or terminal, consisting of spike-like racemes with shortly reddish brown hairs. The flowers are bisexual, regular and red-brown in colour. The fruit is a flat, elliptical, dehiscent, leathery pod with ovoid seeds. *Erythrophleum ivorense* has been recorded in Cameroon, Central African Republic, Côte d'Ivoire, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea Bissau, Liberia, Nigeria and Sierra Leone in evergreen primary and secondary forest and moist semi-deciduous forest.[2]

Medicinal uses of *Erythrophleum ivorense*

The bark, leaves and stem bark of *E. ivorense* are mainly used as anthelmintic, emetic, insect repellent, laxative and traditional medicine for convulsions, malaria, pain, smallpox, swellings and wounds (Table 1). In Gabon, the stem bark of *E. ivorense* is mixed with the leaves of *Brenania brieyi* (De Wild.) E.M.A. Petit, bark of *Erythrina* spp. and the leafy twigs of *Ficus exasperata* Vahl and *Plagiostyles africana* (Müll. Arg.) Prain as traditional medicine for blennorrhagia and urethritis.[14] In Gambia, the bark and leaves of *E. ivorense* are mixed with those of *Alstonia boonei* De Wild., *Annona muricata* L., *Anopyxis klaineana* (Pierre) Pierre ex Engl., *Citrus aurantifolia* (Christm.) Swingle, *Citrus sinensis* (L.) Osbeck, *Cocos nucifera* L., *Turraeanthus africana* (Welw. ex C.DC.) Pellegr. and *Thaumatococcus* spp. as traditional medicine for malaria.[18,19]

Table 1: Medicinal uses of *Erythrophleum ivorense*

Medicinal use	Parts used	Country	References
Anthelmintic	Stem bark	Nigeria	Oliver-Bever[20]; Wakeel et al.[21]; Armar et al.[22]; Njimoh et al.[23]; Armar et al.[24]
Anti-poison	Leaves	Nigeria	Aniama et al., 2016
Blennorrhagia and urethritis	Stem bark mixed with leaves of *Brenania brieyi* (De Wild.) E.M.A. Petit, bark of *Erythrina* spp., and twigs of *Ficus exasperata* Vahl and *Plagiostyles africana* (Müll. Arg.) Prain.	Gabon	Neuwinger[14]
Convulsions	Stem bark	Nigeria	Oliver-Bever[20]; Wakeel et al.[21]; Armar et al.[22]; Njimoh et al.[23]; Armar et al.[24]; Armar et al.[26]; Anning et al.[27]
Emetic	Stem bark	Nigeria and Sierra Leone	Bosch[2]; Bosch[3]; Oliver-Bever[20]; Wakeel et al.[21]; Armar et al.[22]; Njimoh et al.[23]; Armar et al.[24]; Ogboru et al.[28]; Kyere-Davies et al.[29]
Insect repellent	Bark and leaves	Cameroon and Nigeria	Cobbinah et al.[30]; Kayode et al.[31]; Youmsi et al.[32]
Laxative	Bark	Nigeria and Sierra Leone	Bosch[2]; Bosch[3]; Oliver-Bever[20]; Wakeel et al.[21]; Armar et al.[22]; Njimoh et al.[23]; Ogboru et al.[28]; Kyere-Davies et al.[29]
Lumbago	Stem bark	Gabon	Betti et al.[33]
Malaria	Bark and leaves mixed with *Alstonia boonei* De Wild., *Annona muricata* L., *Anopyxis klaineana* (Pierre) Pierre ex Engl., *Citrus aurantifolia* (Christm.) Swingle, *Citrus sinensis* (L.) Osbeck, *Cocos nucifera* L., *Turraeanthus africana* (Welw. ex C.DC.) Pellegr. and *Thaumatococcus* spp.	Ghana	Abbiw[18]; Asase et al.[19]
Pain	Bark	Nigeria and Sierra Leone	Bosch[2]; Bosch[3]; Oliver-Bever[20]; Wakeel et al.[21]; Armar et al.[22]; Njimoh et al.[23]; Armar et al.[24]; Ogboru et al.[28]
Skin problems (cutaneous diseases)	Bark	Gabon	Cédric et al.[34]
Smallpox	Bark	Côte d'Ivoire, Gabon and Nigeria	Bosch[2]; Bosch[3]; Neuwinger[14]; Oliver-Bever[20]; Wakeel et al.[21]; Armar et al.[22]; Njimoh et al.[23]; Armar et al.[24]; Armar et al.[26]; Anning et al.[27]; Ogboru et al.[28]; Cédric et al.[34]
Swellings	Stem bark	Nigeria	Oliver-Bever[20]; Wakeel et al.[21]; Njimoh et al.[23]
Ulcers	Bark	Gabon	Cédric et al.[34]
Wounds	Leaves	Cameroon	Anning et al.[27]; Jiofack et al.[35]; Adu-Amoah et al.[36]

Table 2: Phytochemical compounds identified from *Erythrophleum ivorense*

Chemical compound	Value	Plant part	Reference
3β-Acetoxydinorerythrosuamide	-	Root bark	Armah et al.[26]
3β-Acetoxynorerythrosuamide	-	Root bark	Armah et al.[26]
22-Acetoxy-6α-hydroxy-nor-cassamide	-	Root bark	Armah et al.[26]
Alkaloid (mg/kg)	58.9	Bark	Ogboru et al.[28]
Ash (mg/kg)	63.1	Bark	Ogboru et al.[28]
Betulinic acid	-	Root bark	Armah et al.[22]; Armah et al.[24]; Armah et al.[26]
Carbohydrates (mg/kg)	57.6	Bark	Ogboru et al.[28]
Cardiac glycoside (mg/kg)	37.5	Bark	Ogboru et al.[28]
Cassaic acid	-	bark	Cronlund[42]
Cassaide	-	Stem bark	Cronlund and Sandberg[44]
Cassaidic acid	-	bark	Cronlund[43]
Cassaidine	-	Bark	Cronlund and Sandberg[44]; Cronlund[45]
Cassaine	-	Bark	Cronlund and Sandberg[44]; Cronlund[45]
Cassamic acid	-	bark	Cronlund[43]
Cassamide	-	Stem bark	Cronlund and Sandberg[44]
Cassamidine	-	Bark	Cronlund and Sandberg[44]; Cronlund[45]; Schultz and Hoenicke[46]
Cassamine	-	Bark	Cronlund and Sandberg[44]; Cronlund[45]; Schultz and Hoenicke[46]
Copper (ppm)	3.8	Bark	Ogboru et al.[28]
Coumidine	-	Bark	Cronlund and Sandberg[44]; Cronlund[45]
Eriodictyol	-	Root bark	Armah et al.[22]; Armah et al.[24]; Armah et al.[26]
Erythroivorensin	-	Root bark	Armah et al.[22]; Armah et al.[24]; Armah et al.[26]
Erythrophlamine	-	Bark	Cronlund and Sandberg[44]; Cronlund[45]; Schultz and Hoenicke[46]
Erythrophleguine	-	Bark	Cronlund and Sandberg[44]; Cronlund[45]; Schultz and Hoenicke[46]
Erythrophlamide	-	Stem bark	Cronlund and Sandberg[44]
Flavonoid (mg/kg)	33.8	Bark	Ogboru et al.[28]
Fat (mg/kg)	0.02	Bark	Ogboru et al.[28]
Fibre (mg/kg)	130.8	Bark	Ogboru et al.[28]
19-hydroxycassaine	-	Stem bark	Cronlund[43]; Cronlund and Sandberg[44]
6α-Hydroxydinorcassamide	-	Root bark	Armah et al.[26]
6α-Hydroxy-nor-cassamine	-	Root bark	Armah et al.[26]
6α-Hydroxy-nor-erythrophlamide	-	Root bark	Armah et al.[26]
7β-Hydroxy-7-deoxo-6-oxonorcassaide	-	Root bark	Armah et al.[26]
Iron (ppm)	42.2	Bark	Ogboru et al.[28]
Ivorine	-	Bark	Cronlund[43]; La Barre et al.[47]
3-(3-Methylcrotonyl)cassaine	-	Bark	Cronlund[43]
Moisture content (mg/kg)	4.4	Bark	Ogboru et al.[28]
Norcassaide	-	Root bark and stem bark	Armah et al.[26]; Cronlund[43]; Cronlund and Sandberg[44]
Norcassamide	-	Stem bark	Cronlund[43]; Cronlund and Sandberg[44]
Norerythrophlamide	-	Stem bark	Cronlund[43]; Cronlund and Sandberg[44]
Phenolic (mg/kg)	10.1	Bark	Ogboru et al.[28]
Phosphorus (ppm)	2.1	Bark	Ogboru et al.[28]
Protein (mg/kg)	201.5	Bark	Ogboru et al.[28]
Saponin (mg/kg)	41.6	Bark	Ogboru et al.[28]
Sodium (ppm)	214.5	Bark	Ogboru et al.[28]
Steriods (mg/kg)	6.0	Bark	Ogboru et al.[28]
Tannin (mg/kg)	31.2	Bark	Ogboru et al.[28]
3β-Tigloyloxydinorerythrosuamide	-	Root bark	Armah et al.[26]
3β-Tigloyloxynorerythrosuamide	-	Root bark	Armah et al.[26]
Total flavonoid content (mg GAE/10g)	16.8 – 156.0	Leaves	Cédric et al.[34]
Total phenolic content (mg GAE/10g)	10.1 – 1434.6	Leaves and bark	Ogboru et al.[28]; Cédric et al.[34]
Vitamin C (mg/kg)	8.1	Bark	Ogboru et al.[28]
Zinc (ppm)	21.7	Bark	Ogboru et al.[28]

Phytochemistry and biological activities of *Erythrophleum ivorense*

The bark, root bark and stem bark of *E. ivorense* contain alkaloids (Table 2) and cardiotonic, anaesthetic and diuretic properties of the species are attributed to some of these compounds.[14] Other phytochemical compounds that have been identified from the leaves, stems and stem bark of *E. ivorense* include anthracenosides, cardiac glycosides, condensed tannins, coumarins, flavonoids, hydrolysable tannins, phenolics, saponins, sterols and terpenoids.[21,23,34,37] The following biological activities have been reported from the bark, leaf, root bark and stem bark extracts of *E. ivorense* and compounds isolated from the species: antibacterial,[23,34,36,38] antifungal,[34,36] anticonvulsant and sedative,[21] antigiardial,[39,40] anti-inflammatory,[22] anti-leishmanial,[26,27] antioxidant,[34] antischistosomal,[24,29] antitrypanosomal,[41] insecticidal[42] and cytotoxicity[36,37] activities.

Antibacterial activities

Atindehou et al.[38] evaluated the antibacterial activities of ethanol leaf extracts of *E. ivorense* against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Enterococcus faecalis* using agar-well diffusion and broth microdilution assays. The extract exhibited activities against *Staphylococcus aureus* and *Enterococcus faecalis* with the inhibitory concentration 100% (IC_{100}) values ranging from 188.0 µg/mL to 375.0 µg/mL.[38] Adu-Amoah et al.[36] evaluated the antibacterial activities of methanolic leaf and stem bark extracts of *E. ivorense* against *Pseudomonas aerugenosa*, *Escherichia coli*, *Staphylococcus aureus* and *Bacillus subtilis* using the micro-dilution method. The extracts exhibited activities with minimum inhibitory concentration (MIC) values ranging from 2.0 mg/mL to 8.0 mg/mL.[36] Cédric et al.[34] evaluated the antibacterial activities of water, water-ethanol and ethanol leaf extracts of *E. ivorense* against *Pseudomonas aerugenosa*, *Shigella flexneri*, *Escherichia coli*, *Shigella dysenteria*, *Staphylococcus aureus* and *Enterococcus faecalis* using agar-well diffusion and broth microdilution assays with kanamycin (10 µg) as a positive control. The extracts exhibited activities with zone of inhibition ranging from 7.0 mm to 16.0 mm against 15.0 mm to 32.0 mm exhibited by the control. The MIC values ranged from 0.63 mg/mL to 1.25 mg/mL while the minimum bactericidal concentration (MBC) values ranged from 1.25 mg/mL to >2.5 mg/mL.[34] Njimoh et al.[23] evaluated the antibacterial activities of ethanol, hexane and methylene chloride stem bark extracts of *E. ivorense* against *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Providencia stuartii* and *Proteus vulgaris* using the well diffusion and broth microdilution methods with gentamycin as a positive control. Only ethanol extract exhibited activities with zone of inhibition ranging from 8.0 mm to 13.1 mm against 14.6 mm to 21.0 mm exhibited by the positive control. The MIC and MBC values of ethanol, hexane and methylene chloride extracts against tested pathogens ranged from 1.0 mg/ml to 11.0 mg/ml.[23]

Antifungal activities

Adu-Amoah et al.[36] evaluated the antifungal activities of methanolic leaf and stem bark extracts of *E. ivorense* against *Candida albicans* using the micro-dilution method. The bark and leaf extracts exhibited activities with MIC values of 2.0 mg/mL and 4.0 mg/mL, respectively.[36] Cédric et al.[34] evaluated the antifungal activities of water, water-ethanol and ethanol leaf extracts of *E. ivorense* against *Candida albicans* using agar-well diffusion and broth microdilution assays with kanamycin (10 µg) and nystatin (100 IU) as positive controls. The extracts exhibited activities with zone of inhibition ranging from 7.0 mm to 8.0 mm against 20.0 mm exhibited by the two controls. The MIC values ranged from 0.63 mg/mL to 1.25 mg/mL while the minimum fungicidal concentration (MFC) values ranged from 2.5 mg/mL to >2.5 mg/mL.[34]

Anticonvulsant and sedative activities

Wakeel et al.[21] evaluated the anticonvulsant and sedative activities of ethyl acetate and methanol extracts of *E. ivorense* stem bark in male Swiss mice using picrotoxin, pentylenetetrazole and strychnine-induced convulsion and sedative effect was evaluated using pentobarbitone-induced hypnotic method. The extracts delayed the onset, shortened the duration and offered protection against pentylenetetrazole-induced convulsion. The extracts also antagonized picrotoxin-induced convulsion profoundly but did not antagonize strychnine-induced convulsion. The extracts also prolonged the time of sodium pentobarbital-induced hypnosis and the median lethal dose (LD_{50}) of the methanol extract was found to be 87.0 mg/kg.[21]

Antigiardial activities

Kyere-Davies et al.[39] evaluated the antigiardial activities of ethyl acetate stem bark extract of *E. ivorense* against *Giardia lamblia* using *in vitro* susceptibility assay with metronidazole as a positive control. The extract exhibited activities with half maximal inhibitory concentration (IC_{50}) value of 13.8 µg/ml.[39] Similarly, Kyere-Davies et al.[40] evaluated the antigiardial activities of acetone, ethyl acetate, petroleum ether and methanol leaf and stem bark extracts of *E. ivorense* against *Giardia lamblia* using *in vitro* susceptibility assay with metronidazole as a positive control. Only ethyl acetate stem bark extract exhibited activities with IC_{50} value of 13.8 µg/ml.[40]

Anti-inflammatory activities

Armah et al.[22] evaluated the anti-inflammatory activities of crude aqueous-alcohol root bark extract of *E. ivorense* and compounds erythroivorensin, betulinic acid and eriodictyol isolated from the species using the carrageenan paw edema model in chicken with diclofenac as a positive control. The crude extract demonstrated a time and dose, 30 mg/kg to 300 mg/kg p.o. dependent activities while the compounds exhibited a dose, 10 mg/kg to 100 mg/kg p.o. dependent activities which were comparable to activities exhibited by the positive control.[22]

Anti-leishmanial activities

Armah et al.[26] evaluated anti-leishmanial activities of the crude root bark extract, ethyl acetate, methanol and petroleum ether fractions of *E. ivorense* as well as compounds betulinic acid, eriodictyol and erythroivorensin isolated from the species against the promastigote forms of *Leishmania donovani* using a direct counting assay based on growth inhibition with amphotericin B as a positive control. The crude extract, fractions and isolated compounds with the exception of betulinic acid exhibited weak to moderate activities with IC_{50} values ranging from 3.0 µg/ml to 133.6 µg/ml.[26] Anning et al.[27] evaluated the anti-leishmanial activities of the ethanolic leaf extract of *E. ivorense* against the promastigote stage of the *Leishmania enriettii* using the trypan blue quantification assay. The extract demonstrated activities with the extract exhibiting MIC value of 62.3 µg/ml which was observed after 72 hours.[27]

Antioxidant activities

Cédric et al.[34] evaluated the antioxidant activities of water, water-ethanol and ethanol leaf extracts of *E. ivorense* using the 2,2'-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay with ascorbic acid and butylated hydroxyanisole (BHA) as positive controls. The extracts exhibited activities with IC_{50} values ranging from 17.4 µg/mL to 31.5 µg/mL which was comparable to 9.2 µg/mL to 13.3 µg/mL exhibited by the positive control.[34]

Antischistosomal activities

Kyere-Davies et al.[29] evaluated the phenotypic effects of acetone, petroleum ether, ethyl acetate and methanol leaf and stem bark extracts of *E. ivorense* on two developmental stages of *Schistosoma mansoni*. The extracts were incubated with somules at 0.3 µg/mL to 100.0 µg/mL and with adults at 1.25 µg/mL. The extracts exhibited activities against the somules and adult parasites resulting in phenotypic changes.[29] Armah et al.[24] evaluated anti-cercarial activities of 70% ethanolic crude extract, methanolic, ethyl acetate and petroleum ether root bark fractions of *E. ivorense* and the compounds erythroivorensin, betulinic acid and eriodictyol isolated from the species. The *in vitro* anti-cercarial activities were assessed at various concentrations of the extract or compound against freshly shed cercariae from *Schistosoma haematobium*. With the exception of erythroivorensin and betulinic acid at 15.6 µg/mL, all the various fractions and eriodictyol at all concentrations achieved 100% mortality of cercaria within 180 minutes of incubation. The extracts and compounds decreased percentage viability of cercariae in a dose-dependent manner. The IC_{50} values of the extracts ranged between 1.2 µg/mL to 2.1 µg/mL.[24]

Antitrypanosomal activities

Atindehou et al.[41] evaluated the antitrypanosomal activities of ethanol root bark extracts of *E. ivorense* against *Trypanosoma brucei rhodesiense* using the fluorescence assay with suramin as the positive control. The extract exhibited weak activities with IC_{50} value of 15.0 µg/ml.[41]

Insecticidal activities

Akhideno et al.[42] evaluated the insecticidal activities of the aqueous bark extract of *E. ivorense* in the control of stem borer pest (*Sitophilus zeamais*) at varied treatment levels of 0 (control), 5ml/kg, 10 ml/kg, 15 ml/kg and 20 ml/kg. The extract at 10 ml/kg to 20 ml/kg were effective in the control of stem borer and increasing concentration of the extract 20 ml/kg resulted in the highest mortality rate residual action and the reproductive at 89.2%, 76.0% and 0%, respectively.[42]

Cytotoxicity activities

Adu-Amoah et al.[36] evaluated the cytotoxicity activities of methanolic leaf and stem bark extracts of *E. ivorense* using their influences on cell viability, proliferation and cytotoxicity on HaCaT keratinocytes. Within the tested concentrations of 0.1 µg/mL to 100.0 µg/mL, both extracts decreased the viability and proliferation of the HaCaT keratinocytes cells in comparison to the untreated cells.[36] Adu-Amoah et al.[37] evaluated the cytotoxicity activities of methanol leaf and and stem bark extracts of *E. ivorense* on HaCaT keratinocytes and *in vivo* toxicity activities of the extracts on kidney and liver tissues of Wistar rats. Concentrations from 0.1 µg/mL to 100 µg/mL of the extracts were used to determine the effect of the extracts on the release of lactate dehydrogenase (LDH) from HaCaT keratinocytes. The extracts showed increase in LDH released from HaCaT keratinocytes at 0.1 µg/mL to 10.0 µg/mL. Wistar rats were orally administered with 100 mg/kg, 300 mg/kg and 1000 mg/kg body weight of the extracts for 35 days. The extracts exhibited dose and time dependent toxicity as the kidney and liver tissues from rats administered with the extracts showed diseased conditions including inflammation of cells, necrotic tissues and infiltration cells.[37]

CONCLUSION

Erythrophleum ivorense is a known poisonous plant[2] and there is need for detailed clinical and toxicological evaluations of crude extracts and compounds isolated from the species. Much work is required on aspects of quality control to ensure safety and ensure that potentially toxic components of *E. ivorense* herbal products are kept below tolerance levels. Future studies should investigate any side effects and/or toxicity associated with intake of *E. ivorense* herbal products.

Conflict of interest

The author declares that he has no conflict of interest.

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